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# X-Ray Study on Thallium Foils

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CITATION:

Takagi, Hideo ...[et al]. X-Ray Study on Thallium Foils. 京都大学化学研究所報告 1952, 30: 36-38

ISSUE DATE:

1952-09-30

URL:

<http://hdl.handle.net/2433/74464>

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Since the output reading of a crystal detector coupled to the reflected wave by the directional coupler is proportional to  $|I'|^2$ , for the lengths of the liquid which are odd integral multiples of  $\lambda_d/4$ , the set of values of the output reading i. e.  $|I'|^2$  may be written in the form.

$$|I'|^2_n = \frac{\left| \frac{1-Z_d}{1+Z_d} \right|^2 + 2 \left| \frac{1-Z_d}{1+Z_d} \right|^2 \exp(-n\alpha_d \lambda_d/2) + \exp(-n\alpha_d \lambda_d)}{1 + 2 \left| \frac{1-Z_d}{1+Z_d} \right|^2 \exp(-n\alpha_d \lambda_d/2) + \left| \frac{1-Z_d}{1+Z_d} \right|^2 \exp(-n\alpha_d \lambda_d)}$$

$$l = n \cdot \lambda_d/4, n = 1, 3, 5, \dots$$

For the large values of  $n$  and  $\alpha_d$ , the above equation reduces to

$$\frac{|I'|^2_n}{|I'|^2_\infty} = 1 + 2 \left| \frac{1-Z_d}{1+Z_d} \right|^2 \exp(-n\alpha_d \lambda_d/2),$$

where

$$|I'|^2_\infty = \left| \frac{1-Z_d}{1+Z_d} \right|^2.$$

Therefore, the dielectric attenuation per wavelength  $\alpha_d \lambda_d$  is evaluated from the slope of  $\ln \left[ \frac{|I'|^2_n}{|I'|^2_\infty} - 1 \right]$  plotted against  $n$ .

Since  $\lambda_d$  is twice the separation between adjacent maxima of the output reading, the complex dielectric constant will be calculated from the equations (1) and (2).

The observed data on five aliphatic alcohols are shown in the following table.

Dielectric Properties of aliphatic alcohols at  $\lambda_0 = 3.03\text{cm}$

	n-Propanol	iso-Propanol	n-Butanol	iso-Butanol	iso-Pentanol
$\lambda_d$ cm	1.74	1.69	1.83	1.92	1.96
$\alpha_d \lambda_d$ nepers/wavelength	1.146	1.24	0.849	0.800	0.663
$\epsilon'$ (20°)	3.36	3.52	3.13	2.88	2.90
$\epsilon''$ (")	1.11	1.27	0.741	0.634	0.523
$\tan \delta$ (")	0.33	0.36	0.24	0.22	0.18

## 5. X-Ray Study on Thallium Foils

Hideo TAKAGI and Masashige KOYAMA

(H. Takagi Laboratory)

The crystal structure of thallium changes from the close-packed hexagonal (low temp. phase) into the face-centered cubic (high temp. phase) at about 231°C.

On cobalt, having the same structural relation as Tl, it has been studied by U. Dehlinger, Z. Nishiyama, A. R. Troiano, et al. that its high temp. Phase

is able to exist even at room temp. in the case of small grain size. On Ti however, the same study as that on Co has hitherto been reported only by U. Dehlinger. So in this work, a X-ray analysis concerning the abnormal phenomenon above-mentioned, was performed with Ti foils which were rolled and annealed (purity: above 99%; reduction percentage: 50, 70, 90, 99). As Ti is easily oxidized in air, specimens were heat-treated after sealing in glass-tube in vacuum ( $10^{-1}$  mm Hg). The temperature measurement was carried out on the outside of the glass-tube above mentioned. As the X-ray examination at room temperature, both the Laue and the rotation methods, utilizing the heterogeneous X-rays emitted from Cu anticathod, were adopted. In the latter case, specimens were rolled up and were set so that the rotation axis was parallel to the direction of rolling. The results thus obtained will be briefly described below.

In every X-ray photograph of specimens heated at  $240^{\circ}\text{C} \sim 280^{\circ}\text{C}$ , no diffraction Debye ring by the high temp. phase was unexpectedly caught and this result might be due to the fact that the size of micro-crystals was  $10^{-2} \sim 10^{-3}$  cm even at 99 % in reduction by reason of presumable recrystallizing at room temperature.

In the rolled state, the grain size became a little smaller in proportion to the reduction percentage, and the microcrystals were arranged at random in every reduction percentage as in the report of S. Nishikawa, being placed perpendicularly to the incident beam (Fig. 1).

As the result of annealing at  $240^{\circ}\text{C}$  up to 4 hr., it was known that the micro-crystals were arranged at random as in the case of the rolled state.

As for annealing at  $250^{\circ}\text{C}$ , patterns produced by specimens heated for 30~45 min. corresponded to those composed of some single crystals, whose hexagonal base planes were parallel to the surface of specimens (Fig. 2). But when annealed longer, patterns changed to those corresponding to a fibre structure, the grain size being smaller than before (Fig. 3)

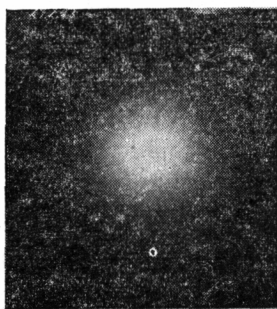


Fig. 1. R=90%, Rolled state.

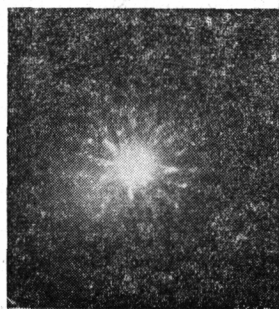


Fig. 2. R=90%, Heated at  $250^{\circ}\text{C}$  for 45 min.

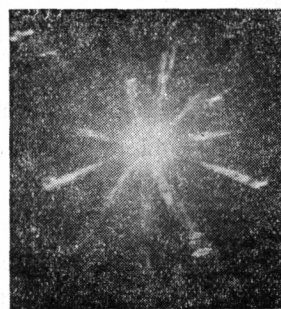


Fig. 3. R=90%, Heated at  $250^{\circ}\text{C}$  for 6 hr.

In the case of  $280^{\circ}\text{C}$ , all diffraction patterns obtained, showed a very com-

plex fibre structure, and the initial relation in which the hexagonal base plane was parallel to the surface of specimen, was likely to change to the state in which the hexagonal c-axis was parallel to the surface of specimen after annealing for a longer time (e. g. 6 hr.)

It was considered that the above mentioned phenomenon observed after passing of two steps of transformations of c.p.h.→f.c.c.→c.p.h., might be resulted from both the grain growth by recrystallization and the transformation.

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## 6. Electron-Microscopic Studies on Vacuum-Evaporated Metallic Thin Films

Nobuji SASAKI and Ryuzo UEDA

(Sasaki Laboratory)

Our specimen-treating adaptor for electron-microscope (Rev. Sci. Instr., 23, 135 (1952) ) was slightly modified to prepare Al and Ba thin films on Formvar film by evaporation in vacuum. These were observed at once to see the effect of air.

The Al film, when very thin, is electron-optically uniform, but, when thick, somewhat granular. On exposure to air at room temperature, the contour of granules becomes slightly indistinct.

A freshly prepared Ba thin film is uniform, but assumes a mossy structure when exposed to air for 15 hours. Ba may have been acted by air.

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## 7. Absorption Spectra and Electron Microgram of Gold Sol

Eiji SUITO and Natsu UYEDA

(Suito Laboratory)

The relationship between the colour of gold sol and its particle size has been a problem of interest for many years. Electron micrographic determination of the particle size enabled us to detect the relationship more precisely. The gold sol used was that of Weimarn, which was prepared by reducing about 80 ml. of 0.005% aqueous auric chloride solution with about 1 ml. of basic formalin solution at room temperature. By changing the volume of reducing reagent solution added to the original solution by 0.2-2.0 ml. many kinds of gold sol, the colour of which varied from red to blue under transparent light, were obtained. The absorption spectra of these gold sol